

Comparative Analysis of the Numerical Solution of the Shallow Water
Equations following different approaches
- Case studies of floods in the North of Madagascar -

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Abstract

Madagascar is ranked among the five most vulnerable countries to climate change (Climate Change and Environmental Risk Atlas-Maplecroft 2011). In 2016, a study estimated average annual losses for the country to be more than 100 million USD for the combined risks (cyclone, flood and earthquake). Flooding accounts for 13% of these losses. These diagnoses have been getting worse and worse in recent years. Controlling these phenomena is becoming a key action for Madagascar. We aim to provide elements of response in this perspective. Indeed, the research is focused on the contribution of flood modeling in Madagascar. The knowledge of depths and velocity fields of water in all flooded or floodable areas is a good start for the chain of characterization of flood hazards. For this we have to solve numerically the Shallow Water Equations. The resolution of these equations requires specific methods and tools. The three most used methods are the finite element method, the finite volume method and the finite difference method. The main objective of this thesis is to compare the efficiency of these three numerical methods. Researchers all over the world are developing since the advancement of computer science specific software that are currently very powerful in terms of modeling flows in natural environment. The three software used are BASEMENT for the finite volume method and IRIC for the finite difference and finite element methods. We have chosen to use some of these tools in order to achieve our goal. Each method has been implemented for some cases of flooding that occurred in northern Madagascar. Our study shows that the finite volume method is the most adequate for the resolution of the Shallow Water Equations. This conclusion confirms the opinion of other researchers who are beginning to move more and more towards the use of this method. Obtaining good results does not only depend on the method used but also on the quality of the data available.

Keywords : *Shallow Water Equation, Finite volumes, Finite elements, Finite differences, Flooding, Madagascar*